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UTILIZATION OF FARM WASTES IN FEEDING LIVE STOCK

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LIVE-STOCK MEN of this country are confronted with a situation unparalleled in history. The unprecedented demand for grains for human consumption makes it imperative that such products be conserved to the utmost and that only those feeds be used for live stock which are not needed for human food.

It is the duty of our stockmen to assist in the provisioning of the great armies engaged in military and industrial pursuits both in this country and abroad. They must also preserve their breeding animals in such a manner that their usefulness will be increased. This will necessitate the utilization of many farm products which in the past have been entirely or partially wasted.

More than one-third of the total production of grain straw in the United States is not being used to advantage, and of this amount one-half is an absolute loss. Of the 245,000,000 tons of corn stover produced annually in the United States it is estimated that only 81.5 per cent is fed to stock, and that at least 35 per cent of this amount is lost through wasteful methods of feeding. During the past years large quantities of cottonseed meal have been used for direct fertilizing purposes, six of the Southeastern States having used in 1914 nearly 1,000,000 tons for such purposes. This meal is worth from \$30 to \$40 a ton for feeding cattle, and not over 25 per cent of its fertilizing value is lost when it is so used.

This bulletin points out methods whereby these wastes may be eliminated, our herds and flocks economically maintained, and the amount of grain used for the feeding of live stock reduced to the minimum.

UTILIZATION OF FARM WASTES IN FEEDING LIVE STOCK.

CONTENTS.

Page.		Page.
Present conditions.....	3	The use of straw, stover, and cotton seed in
Production and use of straw.....	4	rations—Continued.
Production and utilization of corn stover.....	5	For beef cattle.....
Wasteful use of cottonseed meal.....	7	For dairy cattle.....
The use of straw, stover, and cotton seed in rations.....	7	For sheep.....
		For horses.....

PRESENT CONDITIONS.

THE misuse of the by-products of farm crops is causing American farmers to lose millions of dollars annually. Nothing offers greater opportunity for increased and more economical production of farm meats and dairy products than by the more effective use of such products. To bring our farming operations up to the highest possible state of efficiency, all farm by-products must be used in an economical manner. Nearly all managers of the great industries of this country have learned that by-products constitute a very large source of their income and about all the profits. Farming is the greatest industry in this country to-day, but farm by-products have received very little attention from the average farmer. Now, however, conditions are such as to urge the conservation of every available farm resource and every American farmer must make a study of conditions existing on his own farm with the idea of utilizing such products as are now being wasted.

It is estimated that the total amount of corn stover and straws burned, plowed under, allowed to rot in stacks, and wasted in other ways is worth over \$100,000,000. This is an appalling loss, and if these feedstuffs were used in the feeding of cattle, sheep, and horses it would result in greatly increased profits to individual farmers as well as tend to increase the supply of meat and dairy products.

Cottonseed meal, which at this time is being used as a direct fertilizer, could first be used with these roughages in the feeding of all kinds of live stock with great profit, for little of the fertilizing value of cottonseed meal is lost through feeding. The quantity of cottonseed meal annually used as a direct fertilizer in six southern States is

estimated to be nearly 1,000,000 tons, representing an approximate value of \$35,000,000. If the meal were fed and the resulting manure used as fertilizer its value to the farmer would be increased from 50 to 85 per cent. The wasted straw and stover could hardly be utilized, except in combination with large quantities of concentrated feeds, and this cottonseed meal would be enough to almost completely furnish the concentrate portion of a balanced ration composed of straw, corn stover, and the meal.

The Office of Farm Management, after three years' study of corn-belt cattle, has found that the breeding herds maintained most largely on roughages, such as oat or wheat straw, corn stover, etc. (with a very small quantity of concentrate feed such as cottonseed meal, corn, etc.), are the herds from which the largest profits are returned. During 1914 the Animal Husbandry Division and the Bureau of Crop Estimates of the Department of Agriculture made a survey of certain farm crops to determine the extent to which they were being utilized.¹ The results of this survey, while not directly applicable at this time, represent a condition which existed in the past and which still prevails.

The discussion of all farm wastes will not be attempted, but only such as are most apparent at the present time.

PRODUCTION AND USE OF STRAW.

The following table shows the estimated quantity and percentage of the various kinds of straw used for different purposes:

Uses made of straw.

Kind of straw.	Yield per acre.	Value per ton..	Total value. ¹	Quantity. ¹								Percentage.				
				Fed.	Burned.	Sold.	Plowed under.	Bedding, etc.	All uses.	Fed.	Burned.	Sold.	Plowed under.	Bedding, etc.		
Wheat.....	Tons. i. 19	\$3.01	\$192,059	28,586	14,357	5,168	7,210	8,486	63,807	44.8	22.5	8.1	11.3	13.3		
Oat.....	1.09	4.57	191,136	30,029	1,506	3,011	2,928	4,350	41,824	71.8	3.6	7.2	7.0	10.4		
Barley.....	.98	2.39	17,762	4,459	988	268	855	862	7,432	60.0	13.3	3.6	11.5	11.6		
Rye.....	1.29	4.90	16,087	791	397	686	696	713	3,283	24.1	12.1	20.9	21.2	21.7		
Rice.....	2.03	6.11	8,603	843	365	79	13	108	1,408	59.9	25.9	5.6	.9	7.7		
All straw....	1.14	3.71	436,867	64,708	17,613	9,212	11,702	14,519	117,754	54.9	15.0	7.8	10.0	12.3		

¹ 100 omitted after each number in these columns.

Of the total amount of straw produced annually in the United States 54.9 per cent, or 64,708,000 tons, is estimated to have been used for feeding purposes, while that used for bedding is estimated at 12.3

¹ Office of the Secretary of Agriculture Report No. 112, Meat Situation in the United States. Part IV. Utilization and Efficiency of Available American Feed Stuffs. Copies of this publication may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents per copy.

per cent, or 14,519,000 tons. Accordingly, the total used in live-stock production would be about 67.2 per cent, or 79,227,000 tons. The straw that was sold, plowed under, and burned amounts to about 32.8 per cent of the total, or 38,527,000 tons. Thus more than one-third of the total production of straw is being used to disadvantage, one-half of which is an almost total loss. If straw is not used by live stock or plowed under, its value as a soil-enriching material is mainly lost. Its chief value as a fertilizing material lies not in its fertilizing elements, but in its tissues as a source of humus. Because of its value as a food and, when used for bedding, as an absorbent of liquid manure, it is very poor economy to plow straw under when it can be used as a feedstuff or bedding material.

The burning of straw, even though the ashes leave a small quantity of additional mineral matter in the soil, results in an almost total loss. It is practiced most largely in the West, mainly because of custom rather than inability to purchase, feed, or market meat-producing animals. The people there have come to believe that straw is of no value because in that section it has never been used for anything. In some of the Western States a campaign has been made by the college of agriculture and institute workers to get farmers to use a portion of their waste straw for spreading over their grain fields.

PRODUCTION AND UTILIZATION OF CORN STOVER.

The estimated total yield of corn stover in the United States is 245,253,000 tons. According to figures from the Bureau of Crop Estimates, the corn stover was disposed of as follows: 57 per cent (142,000,000 tons) was fed to cattle; 23.6 per cent (58,000,000 tons) fed to other live stock; 3.7 per cent (9,000,000 tons) burned; 10.3 per cent (25,000,000 tons) plowed under; 2.6 per cent (6,000,000 tons) sold and 1.9 per cent (4,000,000 tons) used for other purposes, most of which was for bedding. The yield of dry stover, as estimated, varies from 1 to $6\frac{1}{2}$ tons per acre, with the average close to 3 tons per acre. The estimated value is about \$2 a ton.

The disposition of corn stover in the United States is very similar in character to the disposition of straw, though differing somewhat in degree. About 55 per cent of the straw is fed, while 81.5 per cent of the stover is utilized in that way. Of the stover fed to live stock, however, it is estimated that at least 35 per cent is wasted. Straw is burned to the extent of 15 per cent, while only 3.7 per cent of the stover is disposed of in that manner. Straw sold amounted to 7.8 per cent, while only 2.6 per cent of the stover is marketed. This is to be expected since straw is more easily handled in marketing. About 12 per cent of all the straw is used for bedding, while less than 2 per cent of the stover is so used.

It is needless to say that burning the stover is a great waste, although it seems to offer a quick and easy method of cleaning the ground preparatory to plowing. This system is most largely practiced where the corn is snapped, or husked, in the field, leaving the stalks standing.

In some sections of the United States cattle are wintered with stover as the sole roughage, supplemented with a little grain. Breeding cows or stockers will winter nicely on stover and oat straw, together with a small quantity of either cottonseed meal, linseed-oil meal, or corn. The meal, when fed without other grain, should be fed in the cake form, preferably of nut size. When fed in that manner it is not lost by dropping through cracks or by being blown away, and is not spoiled by saliva or rain.

In preparing stover for feeding purposes, cutting and shocking under general conditions involves less labor than shredding, and the waste is about offset by the labor factor. Chopping or shredding increases the palatability and reduces the storage space for housing the crop, but the labor involved greatly increases the cost of preparation. If cheap power and labor are available on the farm, shredding or cutting is to be recommended. Dry corn stover may be shredded or cut and put into the silo if sufficient water is added. The waste is greatly decreased in this manner, and the resulting feed somewhat resembles green silage and has been used successfully by some farmers.

Of all methods of handling corn, ensiling is by far the most economical, although, because of the need for the grain itself, not all corn can be put into the silo. Where pastures are not available it is economical to use silage throughout the year. Of the total acreage of corn in 1914 (103,435,000 acres), about 8.1 per cent, or the crop from 8,378,000 acres, was put into the silo. About 10.9 per cent of the total acreage, or 11,274,000 acres, was cut and fed as green feed. Nearly 81 per cent was allowed to mature for grain. Of the corn left to mature for grain 57.7 per cent was snapped. That which was cut and shocked in the field is estimated at 24.9 per cent. That which was cut and hauled to the barn for husking, most of the stover of which was shredded, amounted to 9.1 per cent. Only 2.6 per cent of the corn which was left to mature in the field was pastured or "hogged down." The remainder, or 5.7 per cent, was handled in some other way.

A practice in certain sections which is both uneconomical and wasteful is that of "pulling the fodder," or stripping the leaves from the stalk, leaving the stalks to be burned. Of the corn that is allowed to mature in the field, about 19 per cent is handled in that way. Another wasteful practice is that of "topping" the corn, by which the stalk above the top ear is removed and either stored or shocked

for fodder. About 13 per cent of the matured corn is so handled. Of the stalks left standing in the field, 35 per cent are pastured, 33 per cent are plowed under, and 12 per cent are burned.

The total value of the stover produced in the United States in 1914 was about \$436,867,000. Almost 4 per cent, as stated above, or about \$14,757,000 worth of it was burned. This waste is astonishing when one considers the feeding value of the material thus destroyed. To utilize the wasted straw and stover by feeding to cattle would, of course, involve the use of large quantities of concentrated feeds. From the standpoint of national economics that is just what is needed, since we are annually exporting from this country large amounts of concentrated feeds, such as cottonseed meal and cake, corn, molasses, peanuts, and beans. The utilization of cottonseed meal and other feeds with our wasted straws and stover would mean not only a tremendous saving in the cost of producing meats and dairy products and in the feeding of horses, but also a great saving in the cost of enriching the soil. The losses from these two sources, from a nation-wide standpoint as well as from the standpoint of the individual farmer, constitute a greater total than that of all other losses (except that from disease) occurring upon the American farm to-day.

Another great waste that can well be stopped is the failure to utilize the large area of grass along our roads, lanes, and fence rows. Sheep would utilize this waste and remove one of the greatest breeding places of injurious farm insects. The lower leaves of the corn plant, which usually go to waste, as well as the cut-over grain and hay fields, also offer considerable feed to farm flocks.

WASTEFUL USE OF COTTONSEED MEAL.

It is very difficult to change long-established customs, but the practice of using cottonseed meal as a direct fertilizer should be stopped. The sections in which the practice prevails need more live stock. The output of fertilizer with proper utilization would be much greater, and besides the farmers would get the profits from their herds and flocks. Rations showing how cottonseed meal, straws, and corn stover may be fed to cattle, horses, and sheep are given hereinafter.

THE USE OF STRAW, STOVER, AND COTTON SEED IN RATIONS.

Practical experience as well as experimental work has taught that straw and stover can be used very economically in the rations of almost all kinds of live stock. These roughages are and should be used in the fattening rations of all farm animals except hogs, and should compose the larger part of all wintering or keeping rations for cattle, sheep, and horses. Breeding herds of beef cattle or dry

dairy cows can be successfully kept on rations composed largely of these materials. Flocks of breeding ewes do well with such feeds when some grain is added. Horses doing very light or no work need little grain if given a plentiful allowance of clean, bright straw or stover. Under certain conditions, of course, grain should be added to the ration, but now it should be conserved as largely as possible for human consumption.

FOR BEEF CATTLE.

In an experiment conducted at the Indiana experiment station to test the feeding value of oat straw it was found that a ration of corn silage, corn, and cottonseed meal was just as valuable for economy and extent of gains when used with oat straw as when fed with clover hay. As such a ration is extensively used in various parts of the United States its practical value can readily be seen. Straw and stover are especially valuable for the wintering of breeding herds of beef cattle, and should form a large part of their feed.

Rations suitable for different classes of beef cattle are as follows:

Rations for wintering breeding cows.

Ration 1:

Straw, 10 pounds.
Silage, 20 pounds.
Cottonseed or linseed meal, 1 pound.

Ration 2:

Straw, 20 pounds.
Cottonseed or oil cake, 2 pounds.

Ration 3:

Straw, 10 pounds.
Shock corn, 10 pounds.
Cottonseed meal or linseed meal 1 pound.

Ration 4:

Stover, 35 pounds.
Cottonseed or linseed oil meal, 1 pound.

Rations for feeding 1,000-pound fattening steers.

Ration 1:

Straw, 5 pounds.
Silage, 18 pounds.
Corn, 12 pounds.

Ration 2:

Straw, 8 pounds.
Legume hay, 6 pounds.
Cottonseed cake or linseed cake, 5 pounds.

Ration 3:

Stover, 10 pounds.
Silage, 15 pounds.
Corn, 12 pounds.

Ration 4:

Straw, 5 pounds.
Stover, 15 pounds.
Corn, 6 pounds.
Cottonseed meal, 3 pounds.

In these rations various other feeds may be substituted. In the rations given for wintering breeding cows definite quantities of straw and stover are given. In actual feeding such figures should be somewhat disregarded and the cattle given as much roughage as they will consume.

Yearlings may be fed three-fourths the ration for breeding cows and may be expected to come through the winter in fair to good condition.

For fattening animals straw should always be within reach so that the animal may eat at will. They will usually eat from 3 to 5 pounds daily.

FOR DAIRY CATTLE.

While corn stover and straw from the various cereals are not adapted for producing the largest flow of milk, they may be fed to dairy cattle. The amount to use of these materials will depend, of course, upon the supply at hand on the farm. When an abundance of corn stover is available it should form one of the main sources of dry roughage for dry cows, young stock, and cows in milk. To use stover economically it should be cut or shredded, for then it will be eaten more completely and there will be less waste.

Corn stover may be fed to milking cows without limit, when they receive in addition grain, silage, and some leguminous hay. Under these conditions the ordinary cow will eat a large part of from 6 to 8 pounds of stover daily. For dry cows and young stock the proportion can be greatly increased, care being taken to be sure that there is plenty of protein in the ration. In certain instances corn stover has been cut and put into the silo with the addition of plenty of water, and the resulting silage is of fair quality. If a silo is available, empty or partly so, corn fodder which has been well shocked and is not severely weathered may be ensiled to advantage. Put up in this form it is more convenient for feeding in the barn, and cows will consume more of it than if fed dry.

Oat, barley, and wheat straw can form a considerable portion of the dry roughage for all classes of dairy cattle. Straw is used in much the same proportions as corn stover, and a sprinkling of thin molasses has been found to increase greatly the palatability, causing the cows to consume large quantities of the straw. When feeding barley straw it is advisable to examine the mouths of the cattle occasionally, as the beards of the barley when very dry and stiff sometimes cause painful irritations. Rye straw can not be recommended for dairy cattle, because of danger from ergot and on account of the very tough and fibrous nature of the straw. Buckwheat straw has a very low feeding value and should be used when other roughages are not obtainable, but in no case should any straw be wasted. What can not be fed should be used for bedding.

The following rations containing corn fodder and straw should give good results with dairy stock:

Ration for dry cows, bulls, and heifers.

Corn stover and straw-----	Unlimited.
Clover hay-----	10 pounds.
Corn silage-----	20 pounds.
Cottonseed meal-----	1 pound.
Corn-and-cob meal-----	2 pounds.

Ration for cow about to calve.

Corn stover-----	5 pounds.
Clover hay-----	12 pounds.
Corn silage-----	25 pounds.
Wheat bran-----	3 pounds.

Ration for cow giving 16 pounds of 4 per cent milk.

Corn stover and straw-----	Unlimited.
Clover hay-----	12 pounds.
Corn silage-----	20 pounds.
Cottonseed meal-----	2 pounds.
Corn-and-cob meal-----	3 pounds.

Ration for cow giving from 20 to 25 pounds of 4 per cent milk.

Corn stover and straw-----	Unlimited.
Clover hay-----	12 pounds.
Corn silage-----	25 pounds.
Cottonseed meal-----	2 pounds.
Corn-and-cob meal-----	3 pounds.
Gluten feed-----	3 pounds.

FOR SHEEP.

Breeding ewes consume comparatively large quantities of roughage and need but little grain. Of this roughage corn stover and oat straw may well form an important and economical part, but they should be supplemented by other feeds containing more protein. Sheep will eat about 25 to 35 per cent of the total weight of the stover, leaving the stalks. Wheat straw is not so valuable for sheep feeding as oat straw, while rye straw has practically no value in sheep rations.

This type of roughage should be used as a supplement to a leguminous hay, and the whole ration would be improved by the addition of a succulent feed such as well-kept silage or roots. If but little leguminous hay is available the use of some protein-rich concentrate such as meal from cotton seed, linseed, soy beans, or velvet beans will usually be economical and profitable. Cottonseed meal may well be used to balance up a ration lacking in protein either for breeding ewes or for fattening lambs or wethers. It has been fed to breeding ewes up to one-half pound per head per day without apparent injury, but four ounces a day will usually be found sufficient.^a Care should be taken to see that it is of good quality and free from mold.

The following rations should give good results when supplemented by whatever small quantities of grain may be necessary for the health and thrift of the flock:

Ration 1:

Corn stover 2 pounds (amount eaten, not amount fed).
Legume hay, 2 pounds.

^a See Bulletin 148, Alabama Experiment Station.

Ration 2:

Oat straw, 2 pounds.

Legume hay, 2 pounds.

Ration 3:

Oat straw or corn stover, 1 pound.

Silage, 1½ pounds.

Legume hay, 2 pounds.

Coffey, at the Illinois experiment station, found that when fed to yearling wethers with corn and corn silage, corn stover and oat straw gave practically the same daily gains per head. A third lot getting alfalfa as the dry roughage gained slightly more.

Satisfactory gains have never been made in fattening lambs when corn stover or oat straw has formed the sole roughage. When used with leguminous hay (or leguminous hay and silage) and the usual grain ration, the gains have been but slightly smaller than those obtained when nothing but leguminous hay was used, while the cost of the ration has been considerably decreased.

FOR HORSES.

Cheap feeds, such as straw and corn stover, have a place in the horse ration. For growing colts and for horses doing hard work these roughages may be fed in limited quantities, supplementary to a more nutritious ration.

A caution is timely in regard to feeding bulky roughages low in nutrients. Horses have comparatively small stomachs and their digestive anatomy is in no way suited to handle a great bulk of feed. Little nourishment is derived from a pound of such roughage, and in maintaining a hard-working animal too great a bulk of feed would necessarily be taken into the body. It is therefore desirable to combine with a limited quantity of stover or straw sufficient legume hay, grain, or other nutritious feed to meet the individual requirements of the horse. A small portion of some laxative feed, such as silage, roots, bran, or alfalfa, may well be included in a ration containing a large proportion of corn stover or straw.

Cottonseed meal has met with considerable disfavor among horse feeders, but it may be fed in limited quantities if due care is exercised. It is a very heavy protein concentrate but is not particularly laxative in character, and is quite likely to produce digestive troubles unless the quantity fed is limited. Its proper use is as a supplement to a carbonaceous ration, one-half pound daily being usually sufficient, although in some parts of the South several pounds daily have been fed with success. The more favorable results have come from feeding it in connection with grains and blackstrap molasses. Cottonseed meal is not palatable to horses. In most cases not more than two pounds daily per animal should ever be given, and before that limit is reached special note should be taken of its effect. Most horse feed-

ers prefer the use of oil meal. The following rations are suggested for horses:

Maintenance ration for 1,000-pound idle horse.

Ration 1:	
Corn stover	9 pounds.
Alfalfa hay	3 pounds.
Corn on cob	5 pounds.
Ration 2:	
Oat straw	8 pounds.
Alfalfa	8 pounds.
Cane molasses	3 pounds.

Daily ration for 1,000-pound horse at light work.

Corn stover	5 pounds.
Bermuda hay	5 pounds.
Cottonseed meal	$\frac{1}{2}$ pound.
Cowpeas	2 pounds.
Shelled corn	5 pounds.

Daily ration for 1,000-pound horse at severe work.

Corn fodder	4 pounds.
Alfalfa	12 pounds.
Soy beans (ground)	1 pound.
Shelled corn	12 pounds.

Daily ration for 1,250-pound idle horse.

Ration 1:	
Corn stover	11 pounds.
Alfalfa	5 pounds.
Ear corn	4 pounds.
Ration 2:	
Oat straw	10 pounds.
Pea hay	4 pounds.
Common beets (or other roots or silage)	4 pounds.
Oats	4 pounds.

Daily ration for 1,250-pound horse at light work.

Barley straw	5 pounds.
Alfalfa hay	6 pounds.
Rolled barley	8 pounds.

Daily ration for 1,500-pound idle horse.

Corn fodder (with ears)	18 pounds.
Alfalfa	5 pounds.

